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A series of dissertations for the doctorate in the Imperial Military- medical Academy in the academic year 1901-1902.

MATERIALS
FOR THE STUDY OF THE FATE OF ALCOHOL IN THE ORGANISM OF ANIMALS.

DISSERTATION

For the degree of M. D.

Sh. E. Fridman.

The censors of the dissertation were academician A. J. Danielevski, Prof. N. P. Kravkov and D. E. Kuraev.

(Translated for the Nutrition Laboratory of the Carnegie Institution of Washington by Mr. H. B. Dine, December 1916.)

St. Petersburg.

1901.

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I

Not one of the discoveries which were made at any time in history, brought so much harm to humanity as the discovery of ethyl alcohol.

At first alcohol became known in the 9th century and for a long time after it remained only as a medical substance which served for the purpose of sustaining in acute cases of weakening activity of the heart. But gradually from a medicinal substance it is transformed into an enjoyable substance, and here a row of misfortunes for humanity begins, which grasps deeper and deeper great spheres of society. The spread of venereal diseases, the weakening of family ties, the increase of the number of great crimes,--all these enormous phenomena of individual and collective life are explained chiefly by the abuse of alcoholic drinks.

Several statistical data, many of them borrowed from the "Intoxicationen" of Kobert, are interesting and testify to the great negative significance of this "poison-drink". In England 13203 people died from delirium trmens from 1847 to 1874. Normann Kerr Expressed his opinion in the London international hygiene congress of 1891 that the number of premature yearly deaths on account of non-abstinance from alcoholic drinks reaches 40000 people in England and Ireland. Here it is necessary, according to his opinion, to add the doubly greater number of people which perish from need, diseases, etc. brought about by alcohol. From 1871 to 1876 there died in Berlin 206 people from delirium tremens, while

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in Vienna for the same period 195 people died. In the Charite of Berlin the number of people which yearly seek relief due to delirium tremens beginning with the '80's is in constant increase. In 1877 the number of people that were being cured in Germany from chronic alcoholism and insanities due to it equals 4272, and in 1885 there were 10360 cases due to it. In insane asylums the alcoholics comprise from 28 to 49% of the total number of patients. In Prussia 508 people commit suicide yearly due to alcoholism. In Belgium the abuse of alcoholic drinks reaches enormous proportions. In the time when in England 2.5 liters of brandy are consumed yearly by one person, an average of 4 liters per person is consumed in France, and 12 liters of brandy in Belgium. In England one saloon exists for 190 people, in Holland there is one saloon for 175 people, and in Belgium there is one saloon for every 37 people. In the last 14 years counting to 1890 the population of Belgium increased 14%, while the quantity of brandy consumed increased by 37%. For the same 14 years the number of mentally defective and other spiritually diseased persons increased by 45%, the number of people in jails increased by 74%, the number of suicides by 80%, and paupers and vagrants by 150%. Of all the feeble minded children born 48% have a father a drunkard. The number of people that yearly perish in Belgium directly or indirectly from alcohol reaches 20000. 135 million franks are spent yearly on brandy made of common juniper, not counting the losses caused by intoxicated conditions of the man (Kobert "Intoxicationen" 571.572).

To complete the picture I will give a citation from the

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address of Prof. Mosler given by him on the day of establishment of the Greifswald University in 1888.

"In a great number of civilized governments from 20 to 40% of mental defectives owe their fate to alcoholism. The misfortune is also increased by the fact that many mental diseases are transmitted. For example, it has been proved that out of 300 mental-defective children 145 have alcoholic parents. English physicians even state that half of all diseases in general are due to alcohol."

Among the poor who need public relief in England, 75% fall into poverty on account of alcohol; in Geneva and Paris 80% of the poor were reduced to poverty as a result of alcohol, while in Germany 90%. In the report of Secretary Everett it is evident that in the U.S.A. 3000 million dollars were spent from 1860 to 1870 on alcoholic drinks, and indirectly 600 million dollars; 300000 people perished from alcohol, 100000 children were placed in alms houses, 150000 people in jails and workhouses; 2000 suicides, a loss of property amounting to 10 million and 20000 widows were caused by alcohol (Kober "Intoxicationen").

If intoxication brings about diseases with adults, causes crimes and makes them harmful members of society, intoxication among children draws more gloomy pictures for us. Dr. Combe (Lausanne) 1) gives accounts of alcoholism with children. According to him, alcohol affects children even worse than it does adults?

1) "The Physician" 1898, p. 1005.

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Since the brain of a child is bigger and heavier than that of adults in relation to the rest of the body and since it receives more blood, therefore alcohol produces a greater irritation with children; moreover, the brain of a child is not yet developed and alcohol prevents its growth. Dr. Combe further points out the methods by which children receive alcohol: sometimes they receive it directly, but often alcohol reaches children through mother's milk. Especially much alcohol appears in the milk of those mothers who are not accustomed to it and who take the alcohol believing the falsely spread opinion that alcohol brings forth great quantities of milk. For children a very small dose of alcohol is necessary in order to bring about acute poisoning.

At chronic alcoholic poisoning children have a dull appearance, are pale, speak slowly, stutter, and have poor memory. They are ill often and endure disease worse than children that do not obtain alcohol. St. Vitus' dance, epilepsy, and even diabetes are met among alcoholic diseases of childhood.

A still greater evil which threatens not only the individual child but also the family and society, is brought about by hereditary alcoholism. The children of drunkards are born either with hereditary diseases or are subject to physical, moral and mental diseases. Feeble mindedness, dropsy of the brain, epilepsy, etc. are ordinary diseases in families where the parents are alcoholic. According to Bourneville 1)

1). Annales de medicine et chirurgie infantiles. May 1898.

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The parents of 163 epileptics out 244 diseases are drunkards, according to Lenz out of 83 epileptics, 60 had parents drunkards, according to Kovalevski out of 100 epileptics 60 had parents drunkards, and according to Martin 60 epileptics out of 88 have parents drunkards.

Hereditary alcoholism is the reason for overfilling jails and reformatories with offenders.

Not only confirmed drunkards bring forth children with hereditary defects but it is sufficient for a man usually sober to be intoxicated only one day and then at fecundation in order that the child should be born with hereditary diseases.

According to Kraft-Ebing 1) a degeneration of entire settlements from a physical, mental, and moral point of view is noticed as a result of alcohol.

Drunkenness in Russia cannot be viewed without alarm. In St. Petersburg there were till the introduction of the monopoly 2382 saloons for every 10675 households, that is, one saloon for every 4 homes 2). The yearly consumption of 40 degree brandy by one inhabitant of St. Petersburg without distinction of sex and age is 3 "vedro" (vedro equals 2.7gals). If we compute the amount of brandy consumed by bothe sexes and over the age of 20 we get from 5 to 5.5 vedro per person. In the hospitals of St. Petersburg 16834 alcoholics are

1) Psycopathology p. 234.
2) Report of Dr. Gregoriev at the 7th international conference on alcoholism. "The Physician" 1899, #18, P. 531.

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treated yearly. From 1884 to 1897 the number of suicides per year in St. Petersburg increased from 162 to 459, that is, the number of suicides increased more than by 2.5 times. In 1893 1,225,940 "vedro" of brandy were consumed in the state of St. Petersburg where the population is 1,899,600, that is, twice as much brandy was consumed there than in the states of Arkhangelsk, Vologda, Novgorod, Olonez, and Pskov where the combined population equals to 4,482,000. 1) In 1893 in the whole of Russia 562 million roubles 2) were spent on brandy.

These few lines are sufficient in order to understand the attention which the government and society has paid recently to that evil, and the desire to oppose that evil. Governments brought about drink reforms; society echoed through the publication of articles, pamphlets, and through lectures of ant-alcohol nature, and also through the establishment of temperance societies. Science came with its entire authority to the aid of the government and society, as a result of which a mass of works dealing with alcohol appeared.

Since there is no single organ into which the introduced alcohol should not penetrate and where it should not leave chemical and anatomical traces of its activity, it is thus evident how hard it is for science to bring about a thorough analysis on the question of the effect of alcohol on the organism. Nevertheless, quite a little has been done in that

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1) "The Physician", 1896. P. 31.
2) Report of temperance Nov. 1895. "The Physician" 1895, No. 47, P. 141.

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direction, and with the beginning of the last century there ap appear works which deal with the effect of alcohol on the organism. A great service in the analysis of that question has done medical jurisprudence, since that science, rather than any other branch of medical science, has to deal with groups of people that perished on account of chronic or even acute alcoholism. It studied the anatomical changes of the mucous membrane of the stomach, of the intestines, and of the entire digestive canal, as well as the anatomical changes of the brain and its membranes; it looked for alcohol in the stomach and in the more remote organs, and found it in the lungs, brain, etc.

Kuijperl) relates the results of these investigations which he performed on the organs of drowned persons in order to determine the question whether the people fell into the water in sober or intoxicated condition. The organs were distilled with water and when the first distillation was obtained, the author made a qualitative determination of the alcohol by means of chromic acid, and a quantitative analysis by means of determining the specific gravity. In the brain of one drowned person, the body of which was dissected 22 hours after death 3.5 cc. , and in another case 2.5 cc. of absolute alcohol were found. The contents of the stomach and also the liver contained alcohol; the author does not state the amount.

1) Alcohol im Gehirn bei Trunkenheit. Zeitschrift fur analytische Chemie. Band. 22.

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Montalti 1) studied the corpse of a man dead from acute alcoholism. He performed the dissection five and a half hours after death and found the odor of alcohol in the brain and stomach. Then he subjected various organs to distilation in which case he found so much alcohol in the brain and liver that the latter could have been lighted and burned.

A whole row o f works deals with the physiological effect of alcohol on the organism and the means of its elimination from the organism. Alcohol was found in expired air, in urine, in the mother's milk. Victor Subbotin 2) performed a row of ivestigations on the elimination of alcohol through the lungs and urine and found that in the first five and a half hours from 4.85% to 5.35% of the alcohol introduced into the organism goes through the lungs, while through urine from 0.97% to 2% is eliminated. Again in the first eleven and a half hours the lungs eliminate 12.6%, in the last eleven and a quarter hours of the first day 3.47% is eliminated. In 24 hours about 16% is eliminated through the lungs.

Maurice Nicloux 3), utilizing his perfected method of the quantitative and qualitative determination of alcohol, found it in urine,, in human milk, in cerebrospinal liquid,

I do not even pretend to have even an approximate knowledge of the entire literature on alcohol. That question

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1) Jahresbeircht uber die Leistungen und Fortschritte der gerichtlichin Medicin 1883, I, P.528.
2) Maly's Jahresbericht uber die Fortschirtte der Thierchamie 1870, P.292 to 295.
3) Recherches experimantales sur l'elimanation de l'alcool dans l'organisme. Paris, 1900.

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is too big and its literature is too rich. My aim was to indicate in a few words that the most varying questions dealing with alcohol are touched.

II.

One of the least discussed questions is the fate of alcohol in the organism. This question is quite complicated and broad and a part of it was suggested to me by academician A. J. Danilevski for the present work.

My task was to study and if possible, to solve the following specific problems:

1. Does ethyl alcohol, taken within, reach the brain, liver and muscles?

2. If it does reach, then in comparatively what quantities per unit of mass of the organ?

3. Does ethyl alcohol dissapear from the above organs at a uniform rate?

4. Is there not noticed an especial fixation of ethyl alcohol in the above organs depending upon the properties of their chemical constitution and the quantity of introduced alcohol?

In order to begin to solve these questions it would be necessary to find some hopeful method for the quantitative determination of very small quantities of alcohol, since it may be seen beforehand that even if alcohol is found in the above mentioned organs, it will be in minute quantities.

Let us deal at first with the qualitative determination of alcohol.

Among the qualitative reactions an important place is

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taken up by three:

1)The iodoform reaction. The tested liquid with a solution of caustic potash and with a small quantity of a water solution of iodine gives a yellow precipitate with a characteristic odor of iodoform. In regard to this reaction much was written. Raevski 1) studied distillates from the brains of rabbits which received and did not receive alcohol, by means of the reaction on iodoform, in which case he always found alcohol. It is necessary to note that he distilled the brain over only with water and that the brains of animals that received more or less alcohol gave a iodoform reaction of similar intensity. The distillates of the liver and muscles of animals which did not receive any alcohol also gave an iodoform reaction in which case however the intensity was in direct relation to the quantity of alcohol given to the animal.

The author assumes that for the qualitative analyses of alcohol in animal tissues the iodoform reaction is not necessary since in the animal organism there are, on the one hand, substances which are being transformed, at distillation, into alcohol, and, on the other hand, simply small quantities of alcohol.

Pietro Albertini (Ueber Bildung und Vorkommen von Alcohol und Aldehyd im Orgaismus) 2) came to the conclusion that the iodoform reaction has relation to alcohol and aldehyde with the only difference that at aldehyde this reaction goes

1) Maly's Jahresbericht uber die Fortschritte der Thierchemie. B. 5 S. 1875, Pp. 77, 78.
2)Maly's Jahresbericht uber die Fortschritte der Thierchemie. B. 17, P.75, 1887.

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at cooling, while at alcohol -- only at heating.

Vitali 1) suggests half cc. of the tested liquid be mixed with a small quantity of carbosulphate and one drop of concentrated caustic potash; the mixture is to be shaken and a hard ammonium molibdate and a small quantity of dilute sulphuric acid are added. The precipitating carbosulphate takes a red wine color if alcohol is present. Aldhyde does not give this reaction.

Albertoni Revaglia, basing his experiments on those of Raevsi's, studied the tissues of animals which did not receive alcohol. The distilates really gave reaction on iodoform but did not give the reaction of Vitali. Thus there is no alcohol in fresh distillates.

2. With a restoration of chromic acid the tested liquid, with a saturated solution (at ordinary temperature) of potassium bichromate and with a small quantity of dilute sulphuric acid (I:I) ought to give upon heating a blue or green color and the odor of aldehyde.

3. The obtaining of aldehyde tar 2).

To 50 cc. of the tested liquid 1 cc. of saturated at ordinary temperature potassium bichromate, 4 cc. of dilute sulphuric acid (I:I) and several pieces of pumice are added. If 10 cc. of that mixture is distilled over and boiled for several second with 1.5 cc. of a strong solution of Na HO and then is allowed to cool, then at 0.1% of ethyl alcohola yellow color is noticed in the liquid and aldehyde tar is eliminated. But if there is only 0.05% of alcohol in the tested liquid, then the liquid has a dark yellow color

1) Vitali--Same as note above.
2) I.C. Trech. (The Phy-ician) 1899, No.9, P.241

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0.01% of alcohol hardly gives a yellow color.

As to the quantitative determination of alcohol, let us first of all discuss the physical method, the method of weighing and determining the specific gravity of the tested liquid. For this purpose it is necessary to have very sensitive scales which could show a difference in weight of 0.0001 or even of 0.00001 gr. Knowing the weight of the exact volume of the distilled water at a definite temperature and the weight of the tested liquid of the same volume and at the same temperature, and dividing both these quantities by each other, we obtained the specific gravity of the tested liquid. If besides alcohol and water it contains no other substances which might influence the specific gravity of that liquid, then we may find from the obtained specific gravity the volume of the alcohol present in the given substance.

Page 12 Schulinus 1), in determining small quantities of alcohol from distilates obtained in distilling over the organs, made use of a picnometer which had the following construction. It consisted of a thin glass cylinder and thermometer made so that it served at the same time as a stopper. The thermometer is graduated into 0.2 degrees C. From the upper side of the vessel a thin glss tube, 3 inches in length rises which is covered from the top with a glass cap. The entire apparatus weighed 21677 grams and contained at a temperature of 15.5 degrees C. -- 24014 grams of distilled water. This apparatus was filled with the tested liquid which was always from 5 to 10 degrees C. lower than 15.5 degrees; here attention was paid to the fact that no air bubbles should settle on the walls of the vessel . The apparatus was closed by

1)Uber die Vertheilung des Alcohols im thierischen organismus.

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a the thermometer and was heated. In order to heat the liquid to the required temperature the author took the apparatus in his hands and released it when the temperature reached approximately 15 degrees C. Then the thermometer rose several tenths more and reached 15.5 degrees C. Since the liquid in the apparatus at this temperature had a greater volume than before, several drops of it escaped from the tube. Removing the escaped drops with blotting paper the tube was covered with the glass cap and the entire apparatus was weighed on chemical scales exact to milligrams. Having weighed the entire liquid the author poured it out of the picnometer and filled the latter again with the tested liquid and again determined its specific gravity. These determinations were made until several similar figures in the specific gravities were obtained. Knowing the weight of the tested liquid and distilled water at the same temperatures and volume and dividing the first quantity by the second, the specific gravity of the tested liquid was obtained. The quantity of alcohol was determined by the table of Drinkwater which shows the specific gravity of distilled water mixed with alcohol in various proportions, not more however than 10.07% of alcohol.

In order to varify the table of Drinkwater the author mixed 100 grams of distilled water with 1, 2, 3, etc. grams of alcohol and determined the specific gravity. The table proved correct.

The distilates obtained upon distilling over the organs always have a specific odor which indicates that besides

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water there are present there also other substances which may have an effect on the specific gravity of the tested liquid. Schulinus took for control purposes organs of animals which did not receive any alcohol, distilled them and determined the specific gravity. The distilates always showed a specific gravity equal to that of the distilled water.

P.13 If the organs are subjected to a frequent distillation, the distilates begin to show an alkaline reaction 1) which is due to the presence of amonium in the distilate. The latter may be proved by the reagent of Nessler. The distilate in wh which there is amonium always shows a specific gravity which is somewhat higher than that of distilled water. Therefore, by determining the quantity of alcohol in the distilate, by means of the specific gravity, which contains amonium, we obtain a specific gravity greater than what corresponds to a smaller content of alcohol. Amonium, therefore, hides a sm small quantity of alcohol in its determination by the specific gravity and corrections are necessary for its exact determination.

The chemical method of the quantitative determination of alcohol was first worked out by Lallemand, Perrin, and Duroy 2). The substances to be determined were put into a glass balloon through which a current of air was allowed to pass and which reached from the balloon into a vessel with quick lime, and then into a determined quantity of chromic

1) Dr. L. Thiry. Zeitschrift fur rationelle Medicin Herausgegeben von Heule und Pfeufer. Band 17, 1863, P.166. "Uber den Ammoniakgehalt des Brutes, des Harnes und der Exspirationsluft."
2) Du role de l'alcool et de auesthesique dans l'organisme. L'union medicale 127. 1859. Compare gazette medicale de Paris, 1861. Ser III. Vol. xvI. P. 829.

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acid. The ballon was placed into a water bath and heated to boiling point. The forming water vapors and alcohol vapors together with the current of air passed by the quick lime where the water vapors were absorbed and the alcohol reduced the chromic acid into chromic oxide, changing in this case the brick-red solution of potassium bicromate into geen color. If the color of the tested solution took the same color as that of another solution of chromic acid through which alcohol was passed in abundance, the solution of chromic acid was replaced by another such solution. If the second solution took the same color as the solution saturated with alcohol, it was replaced by a third, etc., until the solution of chromic acid was colored less intensively than that saturated with alcohol. From the quantity of substance subjected to distilation and from the quantity of chromic acid used in this case, the comparative quantity of alcohol was determined. This method of determining alcohol gives the possibility to compute only how many times one organ contains more or less alcohol than another organ. By this method Lallemand, Perrin, and Duroy found that the ratios of the quantities of alcohol in the blood and that of the liver of a animals that received alcohol through a probe equals 1:1.48; the relation of the quantities of alcohol in the blood to that in the brain equals 1:1.75. If alcohol is injected into some vein of the animal the relations of alcohol in the blood, liver and brain to each other are different, namely: 1:1.75 :3

Q.15 Hall Smith 1) repeated the investigations of comparative determination of alcohol by the method of Lallemande, Perrin, and Duroy and came to the following conclusions: not the

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entire alcohol passing through the chromic acid is oxidized, reducing the chromic acid into chromic oxide. If we should place several vessels with chromic acid , one after the other and if we should let through them alcohol vapours, they would all be colored in the same intensity.

The author even placed seven vessels out of which six obtained the same color and the seventh showed a less intensive change. Furhher, a part of the alcohol which passes through the quick lime is absorbed by the latter. This alcohol may be removed from the lime by hard heating. On account of this the author considers the method of the comparative qu quantitative determination of alcohol not altogether reliable.

III

P.15 In my investigations i at first made use of the physical method of the quantitative determination of alcohol by means of scales of Westfal, and then made use of chemical scales by the method of Niclouf.

The scale of Westfal consist of a lever the short of which is thick. ON the long arm are introduced divisions and its end has a hook, a thin platinum wire is put on the hook and on the wire a thermometer from 7 to 8 cm. long and of the thickness of a little finger hangs. If the therometer is immersed into distilled water, the scales incline in the side of the short arm and, in order to bring them into equalibrium, it is necessary to add a certain weight, equal to the weight of the water displaced by the thermometer, on the arm on which the thermometer hangs. Thus, we are dealing here with

1) See page 15. The British and foreign medico-chirurgical Review. Vol. 28 XXVIII, July, 1861, P.232. "Experiments on the chromic acid test for alcohol" Schmidt's Jahrbucher, 1862

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scales constructed on the principle of an areometer. If the water contains alcohol then its specific gravity is less than the specific gravity of the water, that is, the unit of volume of alcohol weighs less than the unit of volume of distilled water at 15 degreesC. The scales enable to determine the specific gravity of the tested liquid to 4 decimal points. Knowing the specific gravity I determine by the table of Fownes (Chemiker Kalendar, Tab. Fownes:to each quantity of alcohol of per cent of the distilled water there corresponds a certain specific gravity of the given liquid) the

4.2 / 19)799 / 76 / 39 / 38 / 3.9 / 19)77.0 / 57 / 17 / 171

3.7 / 21)778 / 63 / 147 / 147

3,5 / 18)627 / 54 / 87 / 90

cohol in per cent, and then by means of compu-
bsolute quantity of alcohol.
impossible to determine by the scales of Westfal
iantities of alcohol, such as hundreths of a cc.
of water of 50 of more cc. Then I made use of
Nicloux 1) which consists of the following:
ould add to a quite dilute solution of alcohol
ss than two parts of alcohol in 1000 parts of
le solution of potassium bichromate and sulphuric
ohol is oxidized, the chromic acid is restored
chromic oxide, and this takes place in propor-
iantity of alcohol in the given solution. If th
nough potassium bichromate or, which amounts to the same thing if the alcohol is abundant, the color obtained is greenish blue from the chromic oxide. On the other hand, when there is an abundance of potassium bichromate

1) Recherches experimentales sur l'alimination de l'alcool dans l'organism par Maurice Nicloux, Paris, 1900.

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(one or two drops) the greenish-blue color changes into greenish-yellow. It is necessary to pay special attention to this one or to the two extra drops of potassium bichromate since they indicate a full oxidation of the alcohol and give the final reaction of that method.

P.17 The solution of potassium bichromate necessary for that purpose is prepared as follows: the above salt is dissolved in hot water to saturation. After the solution is filtered it is allowed to cool; then a part of the salt chrystalises. The chrystalized potassium bichromate is again dissolved in hot water to saturation and is again allowed to chrystalize, and this is repeated three times. This rechrystalization is done in order to obtain pure salt. Then 19 grams of crystalized potassium bichromate are weighed on chemical scales, are placed into a graduated cucurbit and water , which has been twice distilled, is poured to the quantity of 1 liter. After the solution is thus prepared it is poured into a burette graduated into tenths of a cc.

In order to determine the quantity of alcohol 5 cc. of the tested liquid are poured into a test tube. Into that test tube 0.1 -0.2 cc. of the solution of potassium brichromate is pored ~~in~~ and also 3 to 5 cc. of sulphuric acid 66 degrees according to Baume until the yellow color disappears, and then the liquid in the test tube is strongly heated. Then from the burette the solution of potassium bichromate is added by drops, each time heating it to a boiling point, and this is repeated until the blue color changes into green and the green into yellowish green. The reaction is considered fini-

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shed if the yellowish green color becomes constant. If the s solution of potassium bichromate is further added the yellowis h green color changes immediately into yellow color, and even from one drop, which already shows a superfluity of the solution.

In colored reaction it is well to have the control before one's eyes which is expressed in this case by the fact that the determinations of alcohol are made in three test tubes out of which one differs from the other in the quantity of the solution of potassium bichromate poured into it by 0.1cc. , in which case in one test tube the reaction is led to the finish, in the other till 0.1cc. and in the third the solution of potassium bichromate is in the superfluity of 0.1 cc. Thus we obtain three nuances out of which the first is green, the second yellowish green, and the third yellow.

The quantity of solution of potassium bichromate used up indicates how many miligrams of absolute alcohol is found in each cc. of the tested liquid. The absolute quantity of alcohol is computed by the formula $\frac{U.n}{1000}$ where U equals the total quantity of the tested liquid, small n equals the quantity of solution of potassium bichromate in cc. used to bring about the final reaction. If we have 75 cc. of the tes ted liquid, a cc. of solution of potassium of bichromate is used, then the absolute 1.6 quantity of alcohol present in the liquid will be : $\frac{75.\ 1.6}{1000}$ or 0.12 grams.

The method of Nicloux is exact when in the tested liquid not less than one and not more thean two parts of alcohol per thousand parts of water are present . In distilates which

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± 5% error, same as stated by Nicoux.

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contain less than one one-thousandth it is necessary to use a solution of potassium bichromate diluted in two, that is, 9.5 grams of salt per liter of water. Then each cc. of the solution will indicate 0.0005 of absolute alcohol and the formula for computing the total quantity of alcohol will be $\frac{U.n.}{2000}$. In distilates containing more than $\frac{2}{1000}$ of absolute alcohol an ordinary solution of potassium bichromate is used according to the method of Nicloux, but the very distilate on account of the preliminary determination is diluted with water until it contains less than 2 and more than 1:1000 of alcohol.

In order to verify by how much the methods of Nicloux is exact and by how much my eye got accustomed to the color reactions, I took solutions of alcohol of various and known to me concentrations, and also solutions of alcohol of concentrations unknown to me but known to my colleagues in the laboratory and determined the quantity of alcohol. Soon I was enabled to distinguish a change in the color from the adding of one drop of potassium bichromate to the previously added 15 or more drops. Since one drop equals approximately to 0.05 cc. of potassium bichromate the exactness in relation to the alcohol by the method of Nicloux reaches 0.0005 grams of alcohol.

Having such an exact method of the quantitative determination of minimal quantities of alcohol I began to solve the broblems before me.

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IV.

The subjects in my experiments were at first rabbits and then dogs.

By means of a soft catheter I introduced 10% alcohol in such an amount that the animal received about 3 grams of absolute alcohol per kilo of its weight. One group of rabbits received only one dose of alcohol, the other rabbits were given on the 2d, 6th, 14th, and 21st day, giving them daily one dose and to some 2 doses a day. Some animals were intoxicated usually quite early, or in about ten minutes, others after half an hour and even later and recovered from their condition of intoxication within 2 or 3 hours after alcohol was taken. In the intoxicated condition the rabbits lie motionless and breathe rapidly. Some of them are very sensitive to alcohol and become intoxicated right after taking it, and even lose all signs of life. Such animals were placed in warmer quarters where they began to breathe normally after a short time; some of them, and there were quite a number of them perish altogether upon the introduction into the stomach even a half a dose of alcohol.

Wishing to know the comparative distribution of alcohol among the organs in dependence on the nature of the organ as well as on the time passed after its introduction into the organism, I killed the animals after various periods after the last dose: within 1 hour after the last dose, 1.5, 2, 4, 5, 6, 12, 16, 18, and 20 hours. Right after the animals died I made a dissection and took out the organs which interested me, namely, the brain, liver, and muscles.

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The latter were always taken from the hind quarters. The organs, after they have been quickly cut into pieces, were placed into a a cucurbit with a tight fitting stopper, some water was added and was subjected to distillation until a distilate was received equal in weight to 2/3 of the mixture subjected to distilation. The first distilate was usually somewhat turbid and with a strong odor, different for various organs. A very strong and characteristic odor was obtained in the distilates of the liver. The reaction of the first distilate was usually neutral, but was also sometimes alkaline.

To the first distilate I added dilute sulphuric acid until an acid reaction was obtained and distilled it again in the 2/3d quantity on a gas flame, having put under a metallic netting.

The second distilate was entirely transparent and with less odor than the first; reaction was neutral. To this second distilate I added either lime water or a sodium solution until a clearly alkaline reaction was obtained, and then again distilled off 2/3 from it.

The last distilate was entirely transparent and had hardly any odor.

Many authors, for determining small quantities of alcohol are satisfied with one distilation. Schulinus in his first experiment did make use of 3 distilations in his first experiments but performed them always with water. Having noticed then that the distilates have an alkaline reaction, he obtained, by means of Nessler's reagent, a characterisitc precipitate from the presence of amoniac salts. Amonia, as is

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known, affects the specific gravity of a liquid by increasing it; therefore Schulinus, who determined the quantity of alcohol by the specific gravity of the tested liquid, added sulphuric acid to the distilates and avoided thereby the above mentioned error. Besides amonia, H. 2 S o 4 takes up other volatile bases which are found in distilates of animal organs.

The third distilate was measured by its volume and the content of alcohol was determined by method of nNicloux.

V

In all there were 35 experiments performed and they are described below.

Experiment 1.

A rabbit weighing 1420 grams received during 6 days at 4.2 cc. of absolute alcohol (3 grams per kilo per weight) in a 10% water solution. In all he received 25.2 cc. of absolute alcohol in the 6 days. The rabbit well endured the alcohol; in the first half hour the animal was entirely normal, then, either it fell asleep heavily or it lay motionless with open eyes. At the end of 2 hours the rabbit usually recovered. 2 hours after the last dose he was killed. The liver weighed 48 grams, and 96 grams of muscles were cut out from the hind quarters. In the liver 0.163 grams of absolute alcohol were found which is 0.34 grams per 100 grams of the organ. In the muscles 0.178 grams were found which 0.185 grams of absolute alcohol per 100 grams of the organ.

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Experiment 2.

A rabbit weighing 1549 grams received daily for 6 days 4.6 cc. of absolute alcohol; endured it well. 2 hours after the 6th dose he was killed. In the liver weighing 47 grams 0.17 grams were found, which is 0.36 grams of absolute alcohol per 100 grams of the organ. In 104 grams of muscles 0.17 grams were found which is 0.166 grams per 100 grams of the organ.

Experiment 3.

Weight of the rabbit 1228 grams. Animal received daily 3.6 cc. of alcohol and endured it badly; often directly after taking the alcohol it seemed to stop breathing and lay as if dead. As a result it was necessary to wrap him up in rags and to put him in warm quarters, after which he recovered within 2 or 3 hours. The rabbit was killed 4 hours after the 6th dose. Liver weighed 51 grams; 0.17 grams of absolute alcohol found. In 85 grams of muscles 0.14 grams of absolute alcohol was found; thus for every 100 grams of the organ there is 0.337 grams of alcohol in the liver, while in the muscles 0.165 grams of absolute alcohol.

Experiment 4.

Rabbit weighed 1165 grams and received 3.4 cc. of absolute alcohol for 5 days. Endured the alcohol well but became intoxicated within 10 of 15 minutes. In the liver weighing 49 grams 0.17 grams of alcohol was found and in 75 grams of muscles--0.12 grams, which is 0.353 grams per 100 grams of the liver and 0.16 grams of absolute alcohol per 100 grams of the muscles.

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Experiment 5.

A rabbit weighing 1465 grams received during 6 days at 4.4 cc. of absolute alcohol. Was not sensitive to it: remained just as lively after taking the alcohol as before it. Was killed 8 hours after the 6th dose. Weight of the liver 48 grams and muscles-- 115 grams. 0.13 grams of absolute alcohol was found in the liver which is 0.27 grams per 100 grams of the organ. In the muscles 0.151 grams was found which is 0.132 grams per 100 grams of the organ.

Experiment 6.

Weight of the rabbit 1430 grams. Received 4.2 cc. of absolute alcohol for 6 days. Endured the alcohol well. Was killed 8 hours after the 6th dose. In the liver weighing 52 grams 0.14 grams was found or 0.27 grams of absolute alcohol per 100 grams of the organ. In the muscles weighing 123 grams was found 0.16 grams which is 0.13 grams per 100 grams of the organ.

Experiment 7.

Rabbit weighing 1130 grams received for 6 days at 3.3 gr grams of absolute alcohol per day. Endured the alcohol well and was killed 12 hours after the 6th dose. 0.05 grams of absolute alcohol was found in the liver weighing 46 grams which is 0.108 grams per 100 grams of the organ. In 86 grams of the muscles 0.03 was found which is 0.04 grams per 100 grams of the organ.

Experiment 8.

A rabbit weighing 1345 grams received for 6 days 4cc. of absolute alcohol per day . Endured the alcohol well and was

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killed 12 hours after the 6th dose. In the liver 0.05 grams was found at its weight of 50 grams which is 0.10 grams per 100 grams of the organ. In 112 grams of muscles 0.04 grams which is about 0.035 grams per 100.

Experiment 9.

Rabbit weighing 1330 grams received 3.9 cc. of absolute alcohol per day for 6 days. The animal was intoxicated right after taking and recovered in about 3 or 4 hours; was killed 16 hours after the 6th dose. In the liver weighing 51 grams 0.01 grams was found which is 0.02 per 100; in 102 grams of muscles the determination of alcohol was not successful.

P. 24

Experiment 10.

A rabbit weighing 1270 received 3.7 cc. of absolute alcohol per day for 6 days. Endured it well and was killed 16 hours after the 6th dose. In the liver weighing 47 grams 0.01 grams of alcohol was found which is 0.023 grams per 100 grams of the organ. In 92 grams of muscles no alcohol was found.

Experiment 11.

Rabbit weighing 1165 grams received 3.4 cc. of absolute alcohol per day for 6 days and endured it well. Was killed 18 hours after the 6th dose. In the liver weighing 48 grams only traces of alcohol were found and not even traces were found in the muscles.

Experiment 12.

Rabbit weighing 1183 grams received 3.4 cc. of absolute alcohol per day for 6 days. Endured it well and was killed 18 hours after the 6th dose. The liver weighed 46 grams and

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84 grams of muscles were taken. Results the same as in the previous experiment.

Experiment 13.

Weight of the rabbit 1472 grams. Daily portion of alcohol 4.5 cc. Endured it well. Was killed 20 hours after the 6th dose of alcohol and in the liver weighing 58 grams and in the muscles, taken in the quantity of 118 grams, not even a trace was found.

Experiment 14.

Weight of the rabbit 1425 grams. Daily portion of alcohol 4.4 cc . to which was the rabbit very sensitive: was intoxicated immediately and recovered within three or 4 hours. Was killed ~~after~~ 20 hours after the 6th dose of alcohol was taken. In the liver weighing 54 grams and in the muscles, of which 116 grams were taken no traces of alcohol were found.

VI.

In table #1 at the end of the text a review of the first 14 experiments is given, where only the liver and muscles were investigated for alcohol; all animals received relatively the same quantity of alcohol, that is, 3 cc. of absolute alcohol per kilo of the weight of the body for 6 days. The experiments differ in only that the reabbits were killed at different times after the last dose of alcohol was given. The first 2 rabbits were killed two hours after the 6th dose, the next 2 rabbits after 4 hours, the next after 8 hours, 12, 16, 18, and 20. In order to compare the quantities of alcohol in the liver and muscles these quantities are reduced to the unit of 100. We see everywhere that in the liver there is

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2 and 3 times as much alcohol than the muscles, a condition which could have been expected.

If we injected alcohol into some vein, the alcohol together with the bloodwould have reached the ~~small~~ v. cava and passing through the small sphere of blood circulation, ~~it~~ would reach the liver. It is known that the diameter of arteirae hepaticae in man is 5.6 millim. ; the diameter of art. lienalisiis 6.2--6.8 mm., art. renalis 5.6--6.8 mm. 1)

The weight of the human liver is approximately 1400-1900 grams, the weight of the spleen 120-250 grams, weight of the kidney 116-174 grams. From 8 to 9 times less arterial blood reaches the liver than the spleen and from 10 to 12 less than in the kidneys. Therefore if we injected alcohol into some vein, it may be expected that in the liver not more alcohol would reach than in the other organs, and even relatively less alcohol.

We introduced alcohol into the stomach by means of a catheter and hence the conditions of distribution about the organism are entirely different. While the liver is evidently very poorly supplied with arterial blood, it has a very abundant tributary of venous blood from the v. portae 15.79 mm in diameter, which takes in and supplies the liver with blood which passed through the the capillary sanguiferous vessels of the intestinal canal. According to the studies of Rosapelli (Recherches theorique et experim. sur les causes et le mechanisme de la circulation dufoie. Paris,1873) the pressure in the hepatic veins fluctuates between 3--4--7 mm. of mercury, while in the v. portarum from 7 to 16 mm. of the mercury column

1) Hoppe-Seyler. physiological chemistry. Part 2, 1879, P. 322.

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column. If we should add that according to Flugge (Zeitschrift fur Biologie Bd. 13 Heft 2. 1877) It takes almost as much time for blood to pass through the liver of dogs as it does for a full circulation from the femoral vein to the femoral artery, will become plain that it was easy to allow the possibility of a greater accumulation of alcohol in the liver than in the muscles.

As to the disappearance of alcohol from the given organs, it is seen from this table that in the first four hours after the last dose the quantity of alcohol in the liver and muscles remains approximately the same. After 8 hours there remains in the liver as well as in the muscles about 65% of the quanti ty which was in the first 2-4 hours; after 12 hours there remains in the liver and muscles only 30%; after 16 hours there remains in the liver only 10% of the quantity of alcohol which was in the first 2-4 hours; at the same time we find no alcohol in the muscles. After 18 and more hours we find no traces of alcohol either in the liver or muscles.

VII.

In the following 21 experiments the brains, liver and muscles were studied for the quantity of alcohol in them.

Experiment 15.

Rabbit weighing 1375 grams received 4.1 cc. absolute alcohol per day for 6 days. Did not become intoxicated. Was killd 2 hours after the last dose. The brain , liver and muscles were investigated. It was found that although absolutely the brain contained less (0.04) of alcohol than the liver (0.21) and the quantity of muscles taken (0.18), relati-

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vely however, that is, upon reducing to a unit of weight or as in this case 100 grams, there is more alcohol in it than in the liver and muscles. Weight of the brain 7 grams, liver 49 grams, and 92 grams of muscles were taken. Absolute quantity of alcohol found in the brain was 0.04 grams, in the liver 0.21 grams, in the muscles 0.18 grams. Per 100 grams of the weight of the organ 0.50 grams of alcohol was found in the brain, in the liver 0.42, in the muscles 0.19.

Experiment 16.

Rabbit weighing 1508 grams received 4.5 cc. of absolute alcohol per day for 6 days and was killed 2 hours after the 6th dose. Weight of the brain 6.4 grams, liver 49 grams, and muscles taken 114 grams. In the brain 0.035 grams of alcohol was found, in the liver 0.210, in the muscles 0.240 grams. Per 100 grams of the organs-- in the brain 0.56 grams, in the liver 0.43 grams, in the muscles 0.21 grams.

Experiment 17.

Rabbit weighing 1250 grams received 3.9 cc. of absolute alcohol per day for 6 days and was killed 4 hours after the 6th dose was taken. Alcohol was found in the brain 0.026, in the liver 0.170, in the muscles 0.158, or per 100 grams -- in the brain 0.37 grams, in the liver 0.33 grams, in the muscles 0.158 grams, at the weight of the brain of 6.9 grams liver 50.5 grams, and muscles 100 grams.

Experiment 18.

Rabbit weighing 1236 grams received 3.6 cc. of absolute alcohol per day day for 6 days and was killed 4 hours after the 6th dose. Weight of the brain 6.5, liver 50, and 109 gram of muscles were taken. Alcohol found in the brain 0.023 grams

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in the liver 0.177 grams, in the muscles 0.176 grams. Per 100 grams of the organ there is 0.350 grams in the brain, 0.354 in the liver, and 0.160 grams in the muscles.

Experiment 19.

Rabbit weighing 1452 grams received 4.5 cc. of absolute alcohol per day for 6 days and was killed 5 hours after the 6th dose. Weight of the brain 7.2 grams, liver 52 grams, and muscles 124 grams. Alcohol found in the brain -only traces, in the liver 0.174 grams, and muscles 0.202 grams; ~~at the weight of the brain~~ or per 100 grams of the organ; in the brain- traces, in liver 0.335, and muscles 0.163 grams.

P. 29

Experiment 20.

Rabbit weighing 1360 grams received 4.2 cc. of absolute alcohol per day for 6 days and was killed 5 hours after the 6th dose. Weight of brain 7.1 grams, liver 49 grams, and muscles 116 grams. Alcohol found in brain -traces, in liver 0.166 grams, and muscles 0.191 grams. Per 100 grams of the organ there is traces in the brain, 0.34 grams in the liver, and 0.165 grams in the muscles.

Experiment 21.

Rabbit weighing 1291 grams received 3.9 of absolute alcohol per day for 6 days; was killed 6 hours after the 6th dose. Weight of the brain 6.8 grams, liver 47 grams, and muscles 98 grams. Alcohol found in the liver 0.150, in the muscles 0.158 grams; no alcohol was found in the brain. Per 100 grams of the organ there was in the liver 0.32 grams, and in the muscles 0.160 grams of alcohol.

Experiment 22

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Rabbit weighing 1325 grams received 3.9 cc. of absolute alco-

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hol per day for 6 days and was killed 6 hours after the 6th dose. Weight of the brain 6.7, liver 49 grams, and muscles 104 grams. Alcohol found in liver 0.159 grams, and in the muscles 0.174 grams; no alcohol was found in the brain. per 100 grams of the organ alcohol in the liver 0.325, and in the muscles 0.168 grams.

Experiment 23.

Rabbit weighing 1250 grams received 3.75 cc. of absolute alcohol per day for 2 weeks and was killed 12 hours after the last dose. Weight of the brain 8.2 grams, liver 45 grams, muscles 120 grams. Alcohol found in the brain 0.045 grams, in the liver 0.170 grams, in the muscles 0.40 grams. Per 100 grams of the organ alcohol found in the brain 0.56 grams, in the liver 0.38 grams, in the muscles 0.33 grams.

Experiment 24.

Rabbit weighing 1474 grams received 4.5 cc. of absolute alcohol per day for 14 days. During the first 5 days the rabbit was intoxicated from the received dose and recovered within 2-3 hours. On the 6th and the following days until the 9th inclusive the effect of alcohol on the rabbit was still noticeable: 2-3 hours after the dose it was more mmore motionless than usually. On the following days, evidently, the animal did not react on the given doses of alcohol: it remained brave. 12 hours after the last dose the rabbit was killed. Weight of the brain 8.8 grams, liver 52 grams, muscles 120 grams. Alcohol found in the brain 0.047 grams in liver 0.170 grams, in the muscles 0.360 grams. Per 100 gram of the organ alcohol found in the brain 0.54 grams, in liver

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0.33 grams, and muscles 0.30 grams.

Experiments 25 and 26.

Two rabbits weighing 1510 grams and 1450 grams each received 4.5 cc. and 4.4 cc. of absolute alcohol per day for 14 days, and in the following 7 days received 3cc. of alcohol twice per day. Both rabbits were killed 16 hours after the last dose ; during the last 10 days of their life the effect of alcohol on the animals was noticeable. Weight of the brain 8.5 grams, and 8.2, weight of liver 51 and 46 grams, muscles 75 and 75 grams. The organs of bothe rabbits were distilated together. Alcohol found in the brain 0.1 grams, in liver 0.44 grams, and in muscles 0.63 grams. Per 100 grams of the organ-in the brain 0.60 grams, in the liver 0.46 grams, in muscles 0.42 grams.

Experiment 27.

Rabbit weighing 1490 grams received 4.5 cc. of absolute alcohol twice a day, at the intervals of 12 hours, for 2 days. 5 hours after the last dose the rabbit was killed. Weight of the brain 8.5 grams, liver 54 grams, muscles 100 grams. Alcohol found in the brain 0.03 grams, in the liver 0.18 grams, in the muscles 0.16 grams. Thus per 100 grams of the organ there is in the brain 0.36 grams, in the liver 0.34 grams, and in the muscles 0.16 grams.

Experiments 28 and 29.

Two rabbits weighing 1450 grams and 1525 grams received 4.4 cc. and 4.6 cc. of absolute alcohol twice per day for 2 days. Both rabbits were killed 6 hours after the last dose. Weight of brain 7 and 7 grams, liver 50 and 52 grams, and muscles 75 and 75 grams. The organs were distilated together.

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Alcohol found in the brain 0.049 grams, in the liver 0.357 grams, in muscles 0.255 grams. Thus there is per 100 grams of the organ In the brain 0.35 grams, in the liver 0.35 grams, and in the muscles 0.17grams of alcohol.

Experiment 30.

Rabbit weighing 1170 grams received once 3.5 cc. of absolute alcohol and within 1 hour after the dose, when still intoxicated, was killed. Weight of the brain 6.4 grams, liver 48 grams, muscles 100 grams. Alcohol found in the brain 0.028, in liver 0.192, in muscles 0.25 grams. Thus per 100 grams of the organ there is 0.45 grams, in the brain, 0.40 grams in the liver and 0.25 grams of alcohol in the muscles.

Experiment 31.

Rabbit weighing 1352 grams received once 4.0 cc. of absolute alcohol and while in the state of intoxication was killed one hour after the dose. Weight of the brain 7.2, liver 49 grams, muscles 100 grams. Alcohol found in the brain 0.026 grams, in the liver 0.170 grams, in the muscles 0.22 grams. Per 100 grams of the organ there is in the brain 0.36 grams, in the liver 0.35 grams and in the muscles 0.22 grams. (See Page 35 for Experiment 32)

Experiment 33.

Rabbit weighing 1112 grams received once 3.3 cc. of absolute alcohol and while in intoxicated state was killed 1 1/2 hours after the dose of alcohol. Weight of the brain 7.0 grams, liver 49 grams, muscles taken 100 grams. Alcohol found in the brain 0.030 grams, in the liver 0.137 grams,

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in muscles 0.24 grams, Per 100 grams of the organ there is in the brain 0.45 grams, in the liver 0.28 grams, in the muscles 0.24 grams of alcohol.

Experiment 34.

Rabbit weighing 1342 grams received once 4.0 cc. of absolute alcohol and was killed within 2 hours while still sober. Weight of the brain 8.0 grams, liver 51 grams, muscles taken 100 grams. Alcohol found in the brain 0.025 grams, in the liver 0.122 grams, in the muscles 0.20 grams. There is 0.32 grams in the brain, 0.24 grams in the liver and 0.20 grams of alcohol in the muscles per 100 grams of the organ.

Experiment 32.

Rabbit weighing 1250 grams received once 3.8 cc. of absolute alcohol and was killed in intoxicated state within 1 1/2 hours after the dose of alcohol. Weight of the brain 7.2 grams, liver 52 grams, muscles 100 grams. Alcohol found in the brain 0.025 grams, in the liver 0.13 grams, in the muscles 0.24 grams. Per 100 grams of the organ there is in the brain 0.35 grams, in the liver 0.24 grams, and in the muscles 0.24 grams of alcohol.

Experiment 35.

Rabbit weighing 1220 grams received once 3.7 cc. of absolute alcohol and was killed while in sober condition 2 hours after the dose of alcohol was taken. Weight of the liver 48 grams, brain 6.8 grams, and muscles taken 100 grams. Alcohol found in the brain 0.026 grams, in the liver

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0.105 grams, in the muscles 0.16 grams. Per 100 grams of the organ there is in the brain 0.38 grams, in the liver 0.22 gr. and in the muscles 0.16 grams.

In order to review the last 21 experiments I add table #2 at the end of the text. The table is divided into horizontal and vertical columns.

The first horizontal column signifies the number of experiments and these are placed not in order as they were performed but in dependence upon the time that elapsed after the animal was killed after the last dose of alcohol was taken. The time that the animal was killed is shown in the last column.

The second column shows how many days the rabbit received alcohol.

The third column --how many cc. of alcohol the animal recived daily.

The fourth column shows the amount of alcohol taken for the entire time.

The fifth column-- number of grams of alcohol per 100 grams of the brain.

The sixthshows how many grams of alcohol per 100 grams of the liver.

The seventh column- amount of alcohol per 100 grams of muscles in grams.

The last column has been mentioned above.

The vertical columns are designated by the letters a b c d, etc. .

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The figures enclosed in parentheses show the absolute quantities of alcohol found in the organs.

By glancing at table 2 we see that nearly in all the experiments more alcohol was found in the brain than in the muscles. We further see that the data for the brain and liver fluctuate more than those of the muscles; the data of the latter remain almost the same and little depend upon the time when the animal was killed, whether right after the alcohol was taken or whether after more or less long time.

In the muscles we almost always find about 0.2% of alcohol and only at a continuous giving of alcohol, as we see in experiments 28, 29, 23, 24, 25, 26, do we have 0.3% and 0.4%. Therefore on further study of table 2 we will compare only the data for the brain with those of the liver, the data for the brain among themselves and the data for the liver separately.

Let us say a few words explaining the peculiar phenomenon which is noticed in experiments 19, 20, 21, 22. At the time when the brain of the animal killed 4 hours after the 6th dose of alcohol was taken contains 0.55grams of alcohol per 100 grams of the organ, we find no alcohol at all in the brain of an animal killed 5 hours after the 6th dose of alcohol. It seems as if there is no progression in the diappearance of alcohol from the brain; in the brain we do not find such quantities of alcohol as 0.1 grams or even 0.2 grams per 100 grams of the organ. The last very least quantity of alcohol is 0.35 grams per 100 grams of the substance and further it seems to stop short as if at once, while after

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5 hours after the last dose of alcohol it disappears entirely from the brain. This phenomenon is explained very simply. Alcohol does not disappear so rapidly from the brain, only we cannot find it even with very sensitive method for determining small quantities of alcohol, since its quantity is less than we can determine. That alcohol is found in the brain even after 5 or more hours, is shown by experiments 25, 26, 28, 29. As a result of the fact that in these experiments the organs of 2 rabbits were distilled togetherthe absolute quantity of alcohol in the brain was twicw as large and therefore we determine alcohol even 6 hours after the last dose. In view of all that we place a question mark in all cases where we do not find any alcohol in the brain.

Let us turn to table #2.

From the data in column "a" we see that the rabbit a t one time received 3.5 cc. of absol, was killed 1 hour after and in the brain, liver, and muscles there were found 0.45, 0.4, 0.25 grams of alcohol respectively per 100 grams of the organ. The difference between the quantity of alcohol in the brain and liver is insignificant; the quantity of alcohol in the brain is greater than that in the liver only by 12% (0.45:0.4) and in the second case of the same column (experiment #31) we notice almost the same:there is only 3% as much alcohol in the brain as in the liver. That means that at the end of the first hour after alcohol is taken, almost an equivalent quantity of alcohol per unit of the weight of the organis found in the brain and liver. During the second

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hour the difference between the relative quantity of alcohol in the brain and liver at once becomes quite large. From experiment #32, in which the rabbit was killed 1 1/2 hours after alcohol was taken, there is 46 more (0.35:0.24) alcohol in the brain than in the liver; while in experiment #33 which was performed under similar conditions as #32 (column b) there is 60% (0.45:0.28) more alcohol in the brain than in the liver. This difference in the distribution of alcohol between the brain and the liver continues to be big until the end of the second hour after alcohol was taken. Thu s in columns "b" and "c" in which the animals were killed 2 hours after the alcohol was taken, there is 33% (0.32:0.24) more alcohol in the brain than in the liver as far as experiment #34 is concerned; In experiment #35 there is 73% more (0.38:0.22) in experiment #15 by 19% (0.5:0.42) and in experiment #16 by 30% (0.56:0.43) more alcohol in the brain than in the liver. Later this difference becomes smaller and in the end of the 4th hour after alcohol is taken there is almost the same relative quantity in the brain and the liver.

P.36 And thus at the end of the second hour after alcohol was taken there is considerably more alcohol in the brain than in the liver, while at the end of the fourth hour this difference disappears. This conclusion refers to those cases where the animals received only one dose of alcohol. After alcohol is given continuously, viz. for 6 days, the quantity of alcohol found in the brain and liver is greater than where alcohol was given once, but the difference between

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them is less. Thus in experiments 15, 16 at the end of the second hour we find for the brain such quantities as (0.5 and 0.56) : 100 and for the liver (0.42 and 0.43) : 100, but the difference between them is smaller than in experiments #34 and #35. In experiment #15 the difference in favor of the brain is 19%, in experiment #16 - 30%, while in columns B and C there is more alcohol in the brain than in the liver by 46%, 60%, 33%, 73%.

When alcohol was continued to be given for longer periods such as 14 and 21 days, we meet a very interesting phenomenon which we will discuss presently. Preliminarily we must mention the work of Dr. Tamamshev ("The Physician", 1899, #9 Page 241) .

Tamamshev, according to academician A. J. Danielevski, studied the gradual disappearance of alcohol from the body when taken within. At first the author wanted to be convinced whether there is any alcohol in organisms of animals that did not take any. For that purpose he killed 3 rabbits, took off the hide, took out the stomach, intestines and bladder and subjected the rest to distilation. It proved that even by means of the most sensitive qualitative reactions it was impossible to find the presence of alcohol in the tissues of animals that did not take any. Then he gave the rabbits absolute alcohol, 3 cc. per kilo of weight of the body of the animal in the form of a 10% solution and killed them after alcohol was introduced within 2 hours, others within 5, 10, 24 hours. The technique was the same as in the experiments with the first 3 rabbits. The results showed that after

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137 alcohol was given 47% of it disappears at the end of the second hour, 58% at the end of the 5th hour, 70% at the end of the 10th. The entire alcohol disappears from the organism after 24 hours.

With the above work as a basis to the question as to how to explain such large quantities of alcohol found in the brain of animals that received it for 2 and 3 weeks and killed even after 12 and 16 hours after the last dose, we must answer that it is not the result of a constant and daily accumulation during the 14th and 21st days, since after the first dose the alcohol entirely disappears from the organism after 24 hours. According to Danielevski we see here a hint as to the very important fact of the weakening of the oxidizing property of the organism at chronic taking of alcohol. Consequently the organism, destroying alcohol more weakly , leaves larger quantities of it untouched than at ordinary circumstances. In column D we find greater quantities of alcohol for the brain and liver than in columnC, though the animals were similarly killed 2 hours after alcohol was taken. But in column D the rabbit received alcohol for 6 days at the time when in column C it received only once.

And thus on the basis of all that has been said and tables 1 and 2 we can make the following conclusions:

1. In introducing alcohol into the organism we find a part of it in the brain, liver, and muscles.

2. Other conditions being the same there is relatively more alcohol in the brain than in the liver, and more in the liver than in the muscles.

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3. Alcohol when taken into the stomach gradually spreads about the organism in which case the maximum quantity of alcohol in the organs is found 1 1/2 to 2 hours after it was taken; then the quantity gradually decreases (see table 1). Within 4 hours the quantity of alcohol decreases by 3%; after 8 hours by 35%, after 12hours by about 70% as compared with the quantity which was found after 2 hours; after 18 hours we find only traces of alcohol in the organs studied.

4. The quantity of alcohol found in the brain, liver, and muscles depends upon 1) the number of days during which the animal was given alcohol, namely: the longer the animal is given alcohol the more of it found in these organs, and 2) the time that elapsed between the last dose of alcohol taken and the subsequent death of the animal, namely: the longer the time elapsed the less alcohol we find, and vice ver sa.

IX.

Now let us discuss the question why there is such unequal distribution of alcohol in the designated organs, why there is more alcohol in the brain than in the liver, and more in the latter than in the muscles.

That there gathers more alcohol in the liver than in the muscles may be expected, and for this there are anatomical and physiological reasons which we discussed above. But there are no anatomical reasons which favor the fixation of alcohol by the brain. As to the physiological reason it may consist of two moments, namely,

a) The determining moment might have been the activity

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of the brain mass as a nerve center, or

b) The determining moment might be found in the nature of the chemical constitution of the brain mass.

Professor Danielevski stated the supposition that The REASON FOR THE SPECIALLY SIGNIFICANT ATTRACTION OF ALCOHOL BY THE BRAIN MUST BE LOOKED FOR IN THE PECULIARITY OF THE CHEMICAL CONSTRUCTION OF THE BRAIN.

In order to make an experimental check of that supposition it would be necessary to introduce alcohol under such conditions in which the functional moment would be entirely P. 39 excluded, while in the chemical structure of the brain mass there would take place very insignificant or no changes.

In order to do away with the functional moment it is possible to do so by some strong soporific substance, but the best anaesthestic or narcotic substances contain alcohol or aldehyde groupswhich could serve as obstacles in the quantitative determinations of insignificant quantities of alcohol Besides that no narcotic agent could stop the functioning of the liver and it would have been necessary to make use of some other substance or dose. On account of that we made use of a method which allowed us to determine, in regard to the question which interests us, the significance of the peculiarities of the chemical structure of the brain, liver and muscles, without any participation not only of their active condition but even of the vitality of the tissue. The method is as follows.

The dog was killed by the subcutaneous injection from 10 to 15 cc. of a solution of curarin (1:500). About half an

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hour later when the dog showed no signs of life and was still warm, its thorax was opened, making the least possible cut in order to avoid cutting larger vessels, Then through the cut in the left ventricle of the heart a glass tube thickened at the end was placed in the arch of the aorta. The glass tube, by means of a rubber tube, was connected with a vessel containing the liquid designated to be put through the vessels of the animal. Then both vv. cavae were disected in order to let out the introduced liquid. In order to have control of the liquid passing out of the veins, glass tubes were forced into them. At first a solution of 0.7-0.8% of salt of a temperature from 13 to 15 degrees C. Was passed through in order to force out all the blood. Then this solution was replaced by 1%, 2% or 3% of alcohol in physiological solution which was passed through in the quantity of 2 liters per kilo of the weight of the animal. After that a simple physiological solution was passed through in order to do away with the remaining alcohol in the vessels. The washing through continued usually until the sample taken from vv. cave. sup. et inf. gave no reaction for alcohol. Thus the tissues remained in contiguity with the alcoholic liquid at t the removal of the functions of the organs, even at the gradual destruction of their vitality, but, it must be assumed, at a conservation of their chemical structure and to the moment that the protoplasm became benumbed.

P40

The physilogical solution with alcohol was allowed to pass through slowly during 2 or 3 hours and under a moderate pressure, the glass with the solution was placed about 3/4

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of a meter higher than the animal lying on the table.

After that I took out the liver, brain and cut out about 100 grams of muscles from the hind quarters. I proceeded with the organs the same as with the organs of the rabbits. The absolute quantity of alcohol received was computed per 100 grams of the substance of the organ.

Having noticed that the liver collects liquid very rapidly and becomes inflated and that it is incorrect to compare the relative content of alcohol in the substances of the organs which become inflated in various degrees (the liver is strongly inflated, muscles incomparably less, and the brain becomes inflated very little) , I began to determine the relative content of alcohol in 100 parts of the solid substance. For that purpose I took pieces of the organs weighing about 1 gram and dried them at a temperature of 100-110 degrees C. until a constant weight was obtained. Knowing the exact weight of the piece of organ for and after drying I computed the content of solid substance in the entire given organ. Thus I found that the brain of a dog after fomenting contains on the average of 14.5% of solid substance, liver 13% muscles 19%.

In all 16 experiments were performed on dogs but the solid substance of the organs was determined only in the last 9 cases. But since in the last 9 cases the results were
P41 the same, it may be with great probability allowed that in the first 7 cases the results of the determination of the solid substance would have agreed with the latter. Therefore in table #3 the relative content of alcohol per 100 grams of

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solid substance was computed in all 16 cases as if the data were obtained for the first 7 cases also.

The results of the performed experiments are as follows:

Experiment #1

Weight of the dog 5.5 kilo. 11 liters of 1% alcohol in physiological solution were passed through the aorta. weightof the brain 72 grams, liver 173 grams, muscles 100 grams. Alcohol found in the brain 0.34 grams, in liver 0.62 grams, and muscles 0.32 grams. Per 100 grams of raw substance of the organ there is in the brain 0.48 grams, in the liver 0.36 grams, and in the muscles 0.32 grams.

Experiment 2.

Weight of the dog 5.6 kilo. 11.2 liters of 1% of solution of alcohol was passed through. Weight of the brain 72 grams, liver 180 grams, and muscles 100 grams. Alcohol found in the brain 0.31 grams, in liver 0.65 grams, in muscles 0.24 grams. Per 100 grams of raw substance of the organ there is in the brain 0.432 grams, in liver 0.362 grams, in muscles 0.240 grams

Experiment 3.

Weight of the dog 3.5 kilo. 7 liters of solution of alcohol was passed through. Weight of the brain 56 grams, liver 190 grams, muscles 100 grams. Alcohol found in the brain 0.26 grams, in liver 0.60 grams, in muscles 0.28 grams. Per 100 grams of raw substance of the organ there is in the brain 0.48 grams, in liver 0.32 grams, in muscles 0.28 Grams.

Experiment 4.

Weight of the dog 5.2 kilo. 10.4% liters of 1% of solution of alcohol were passed through the aorta. Weight of

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the brain 70 grams, liver 282 grams, muscles 100 grams. Alcohol found in the brain 0.31 grams, in liver 0.95 grams, in muscles 0.26 grams. Per 100 grams of raw substance of the organ there is in the brain 0.45 grams, in liver 0.34 grams, in muscles 0.26 grams.

Experiment 5.

Weight of the dog 6.4 kilo. 12.8 liters of 1% of a solution of alcohol were passed through the aorta. Weight of the brain 92 grams, liver 380 grams, muscles 100 grams. Alcohol found in the brain 0.38 grams, in liver 1.4 grams, in muscles 0.32 grams. Per 100 grams of raw substance of the organ ther is in the brain 0.42 grams, in liver 0.38 grams, in muscles 0.32 grams.

Experiment 6.

Weight of the dog 6 kilo. 12 liters of 2% of a solution of alcohol was passed through the aorta. Weight of the brain 90 grams, liver 370 grams, muscles 100 grams. Absolute alcohol found in the brain 0.52 grams, in liver 1.70 grams, in muscles 0.36 grams. Per 100 grams of raw substance of the organ there is in the brain 0.58 grams, in liver 0.47 grams and in muscles 0.36 grams of alcohol.

Experiment 7.

Weight of the Dog 4.4 kilo. 8.8 liters of a 2% solution of alcohol was passed through the aorta. Weight of the brain 62 grams, liver 345 grams, muscles 100 grams. Alcohol found in the brain 0.40 grams, in liver 1.79 grams, in muscles 0.33 grams. Per 100 grams of raw substance of the organ there is in the brain 0.64 grams, in liver 0.52 grams, in muscles 0.33 grams.

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Experiment 8

Weight of the dog 13 kilo. 26 liters of a 3% solution of alcohol was passed through the aorta. Weight of the brain 165 grams, liver 820 grams, muscles 100 grams. Alcohol found in the brain 1.44 grams, in liver 3.4 grams, in muscles 0.34 grams. Per 100 grams of raw substance of the organ there is in the brain 0.87 grams, in liver 0.415 grams, in muscles 0.34 grams.

Per 100 grams of solid substance alcohol found in the brain 6.02 grams, liver 3.2 grams, in muscles 1.8 grams.

Experiment 9.

Weight of the dog 7 kilo. 14 liters of a 3% solution of alcohol was passed through the aorta. Weight of the brain 88 grams, liver 440 grams, muscles 100 grams. Alcohol found in the brain 0.70 grams, in liver 2.28 grams, in muscles 0.38 grams. Per 100 grams of raw substance of the organ there is in the brain 0.79 grams, in liver 0.52 grams, in muscles 0.38 grams of alcohol. Per 100 grams of solid substance there is in the brain 5.5 grams, in liver 3.94 grams, and in muscles 2 grams of alcohol.

Experiment 10.

Weight of the dog 6.3 kilo. 12.6 liters of a 2% solution of alcohol was passed through the aorta. Weight of the brain 81 grams, liver 405 grams, muscles 100 grams. Alcohol found in the brain 0.5 grams, in liver 2.25 grams, in muscles 0.32 grams. Per 100 grams of raw substance of the organ there is in the brain 0.62 grams, in liver 0.50 grams, in muscles 0.32 grams of alcohol. Per 100 grams of solid substance

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there is in the brain 4.27 grams, in liver 3.84 grams, in muscles 1.68 grams of alcohol.

Experiment 11.

Weight of the dog 8.2 kilo. 16.4 liters of a 3% solution of alcohol was passed through the aorta. Weight of the brain 107 grams, liver 610 grams, muscles 100 grams. Alcohol found in the brain 0.73 grams, in liver 2.7 grams, In muscles 0.3 grams of alcohol. Per 100 grams of raw substance of the organ there is in the brain 0.68 grams, in liver 0.45 grams, in muscles 0.30 grams of alcohol. Per 100 grams of solid substance there is in the brain 4.68 grams, in the liver 3.46 grams, and in the muscles 1.58 grams of alcohol.

Experiment 12.

Weight of the dog 6.5 kilo. 13 liters of a 2% solution of alcohol was passed through the aorta. Weight of the brain 74 grams, liver 230 grams, and muscles taken 100 grams. Alcohol found in the brain 0.46 grams, in muscle 0.24 grams, in liver 1.1 grams. Per 100 grams of raw substance of the organ there is in the brain 0.62 grams, in liver 0.48 grams, in muscles 0.24 grams of alcohol. Per 100 grams of solid substance there is in the brain 4.3 grams, in liver 3.7 grams and in muscles 1.26 grams of alcohol.

Experiment 13.

Weight of the dog 7.4 kilo. 14.8 liters of a 2% solution of alcohol was passed through the aorta. Weight of the brain 78 grams, liver 380 grams, muscles taken 100 grams. Alcohol found in the brain 0.47 grams, in liver 1.7 grams, in muscles 0.26 grams. Per 100 grams of raw substance of

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the organ there is in the brain 0.6 grams, in liver 0.45 grams, in muscles 0.26 grams. Per 100 grams of solid substance there is in the brain 4.1 grams, in liver 3.4 grams, and in muscles 1.4 grams, of alcohol.

Experiment 14.

Weight of the dog 3.8 kilo. 7.6 liters of a 2% solution of alcohol was passed through the aorta. Weight of the brain 50 grams, liver 240 grams, muscles taken 100 grams. Alcohol found in the brain 0.29 grams, in liver 0.96 grams, in muscles 0.28 grams. Per 100 grams of raw substance of the organ there is in the brain 0.58 grams, in liver 0.4 grams, in muscles 0.28 grams of alcohol. Per 100 grams of solid substance there is in the brain 4.0 grams, in liver 3.1 grams, and in muscles 1.5 grams of alcohol.

Experiment 15.

Weight of the dog 8.5 kilo. 17 liters of a 3% solution of alcohol was passed through the aorta. Weight of the brain 82 grams, liver 430 grams, muscles taken 100 grams. Alcohol found in the brain 0.68 grams, in liver 2.1 grams, in muscles 0.28 grams. Per 100 grams of raw substance of the organ there is in the brain 0.84 grams, in liver 0.48 grams, in muscles 0.28 grams of alcohol. Per 100 grams of solid substance there is in the brain 5.8 grams, in liver 3.7 grams, in muscles 1.5 grams of alcohol.

Experiment 16.

Weight of the dog 5.8 kilo. 11.6 liters of a 3% solution of alcohol was passed theough the aorta. Weight of the brain 65 grams, liver 280 grams, muscles taken 100 grams.

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Alcohol found in the brain 0.53 grams, in liver 1.2 grams, in muscles 0.12 grams. Per 100 grams of raw substance of the organ there is in the brain 0.82 grams, in liver 0.44 grams, in muscles 0.12 grams of alcohol. Per 100 grams of solid substance there is in the brain 5.6 grams, in liver 3.4 grams and in muscles 0.6 grams of alcohol.

X.

Table #3 at the end of the text gives a general review of the 16 experiments performed on the dogs.

The first horizontal column shows the number of the experiment, the second- how strong the solution of alcohol was that was let through the aorta (1%, 2%, 3%), then against the names of the organs follow numbers which designate the number of grams of alcohol per 100 grams of the solid substance of a given organ. Further in the columns "general average" we find numbers which show how large an average of all the 16 experiments may be allowed for the number of grams of alcohol per 100 grams of the solid substance of each organ and what sort of an average number of grams of alcohol is to be allowed for 100 grams of solid substance in the experiments in which was used a 1%, 2%, 3% solution of alcohol.

P46

And here for the fainting and dying tissue, though unconditionally fresh and little changed, we find again the same phenomenon as in the experiments on the living animals:there is relatively more alcohol in the brain than in the liver and more in the latter than in the muscles. On the average for all the experiments 4.24 grams of alcohol is found per 100 grams of solid substance of the brain, in the liver 3.25 grams

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in the muscles 1.53 grams.

The same is noticed in each seperate group of experiments in which either a 1%, 2% or 3% solution of alcohol was used: there is relatively more alcohol in the brain than in the liver, and more in the liver than in the muscles.

The stronger the solution of alcohol passed through the body the larger quantities of alcohol do we find in the brain and in the liver; we do not find this relation in the muscles. At 1% solution of alcohol we find in the brain 3.07 grams of alcohol, at 2%- 4.17 grams, at 3%- 5.5 grams. In the liver at 1% - 2.66 grams, at 2% - 3.58 grams, at 3% - 3.45 grams.

When the strength of a solution is increased from 1% to 2%, the quantity of alcohol in the brain increases by 36% (4.17:3.07), in the liver by 34% (3.58:2.66). When the strength of a solution is increased from 2 to 3% the alcohol in the brain again increases by 32% (5.5:4.17), while the quantity of alcohol in the liver does not increase.

If we compare the quantity of alcohol in the brain on the condition that the strength of the solution is increased from 1% to 3% with similar quantities in the liver, the difference is still greater: the quantity of alcohol in the brain increases by 80% (5.5: 3.07), in the liver hardly by 30% (3.45:2.66).

From all this it may be concluded that the brain substance, independent of the kind of its activity, but only
C47 on the strength of the peculiarities of its chemical structure, which undoubtedly does not lose its significance in the living, functioning organ, has an attractive property in regard to

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alcohol; as a result of which the brain tissue takes out from the circulating blood which carries the alcohol, considerably more of that substance than the liver and muscles and probably more than any other organic tissue:. The more alcohol the blood of the subject contains, the more sharply does this difference between the organs in the matter of taking up the alcohol from the blood express itself; that is, the increase in the quantity of alcohol in the brain goes on much more quickly than its increase in the liver, muscles, and, probably, in all the other parts of the organism. Since the peripheral nerve elements are fully analogous to the brain mass by their chemical structure, we may thus think that they are related to the alcohol the same as the brain as compared with other elements. All this may explain sufficiently the harmful action of alcohol on the nerve centers on the peripheral nerve elements which was noticed by authors in the study of morphological changes in those organs even at acute poisoning of the animal with alcohol.

From all such works one cannot help seeing that the nerve elements, central as well as peripheral, are in general incomparably more sensitive to the harmful influence of alcohol than the elements of the muscles, glands, and other tissues , with the exception perhaps of the endothelium of vessels. To prove directly that the nerve peripheral elements absorbe or pick out from the blood per unit of their mass more alcohol than the non- nerve elements is impossible, bu ton the basis on all the facts in regard to the brain it seems to us fair to conclude and to spread the conclusion drqwn by us for the brain as compared with other tissues of the organism.

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XI.

Of what does the property of the chemical structure of the brain consist?

This property must be looked for in the presence in the brain of such substances which cannot be found in other organs or are found in considerably small quantities. To these substances belong protein, cerebrin, chôlestearin, lecitin, and other little investigated bodies.

With the action of ether at 0 degrees C on the brain tissue transformed by means of water into a gruel like mass, upon removing the ether, dissolving the remainder in 85% alcohol at 45 degrees C., upon cooling and fomenting the precipitate with ether, Liebreich found a body containing nitrogen and phosphurus. He named it protogon and considered it the main integral part of the brain. Hoppe-seyler, Diakonov and Strecker later found that protogon is not an independent body but a compound of cerebrin and lecetin1). At present physiological chemists again in return to the original idea that protogon is a chemical indvidual and an independent and solid body.

The usually obtained cerebrin is not according to Thudichum 2) an independent body but a compound of several varieties. Nevertherless all admit the existence of a group of bodies which have a structure and property of the cerebrin type, representing a white, prous and very light powder which is dissolved in alcohol and ether upon heating.

1) Gorup-Besanez. Lehrbuch der Physiologischen Chemie.

2) Die chemische Coostitution des Gehirns des Menschen und der Thiere. Thubingen 1901. P. 41

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Cerebin constitutes the essential part of the brain and the nerve substance in general.

Colestearin is found in all animal and plant cells but in a great quantity in the substance of the brain and nervesl). B.49. Cholestearin by its nature is represented by the approximate formula $C_{27}H_{45}.OH + H_2O$. It is insoluble in water, is soluble in strong spirits and very easily in ether.

A very important significance in explaining our question has the substance lecitin.

Lecitin is a white chrystaline body, easily soluble in alcohol 2), soluble also in ether, chloroform, benzule, and fats.

Lecitin is found in great quantities in the brain and spinal marrow, 3), yolk of an egg and in the sperm; besides that it is found in the blood, milk, and in any protoplasm in a quantity very mush less than the brain tissue and nerve elements. Lecitin is chiefly found in a grey matter of the brain, namely, 17.2402 parts per 100 parts of solid substance; in the white substance in the brain it is found 9.9045 parts per 100 parts of the solid substance 4).

Common logic suggests the idea that between chemical bodies and their solvent there ought to exist a sort of physical attraction which ought to be more significant the better that solvent is for a given body. This thought gains more probability and significance in our problem if we should leave

1) Neumeister. Lehrbush d. physiol.Chemie. Translation by Zelenkov. Edited by A.J. Danielevski. St. Petersburg, 1900.P90
2)Thudichem. Die chem. Constit. des Gehirns des Menschen und d. Thiere P. 121.
3) Gorup-Besanez Lehrbuch der Physiolog. Chemi. P.180.
4) Chem. structure of the brainby Petrowski. Gorup-Besanez. Lehrb. d. ph. chemi. P. 695.

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the positions of contemporary chemistry which regards solutions as chemical compound and the degree of aolubility, as for example, body A and body B, as a dgree of the chemical relationship between the substances.

The fact that lecitin is easily dissolved in alcohol and that all the above mentioned characteristic parts of the nerve tissue are dissolved by it gives us the right to consider the cause of the special attraction between alcohol and the nerve system as the cause of the fact that alcohol is absorbed by the nerve protoplasm in considerably greater quantity than by the non-nerve protoplasm; and that at comparatively weak and short timed poisoning of the organism with alcohol, the elements of the nerve system are evidently affected, while in other elements no evident deviations from normal are seen.

It is also possible that other tissues containing the above mentioned substances, though in smaller quantities than the brain tissues, are affected by alcohol more than for example such tissues as muscles, for the same fundamental reason. In summing up all that has been said, we make the following conclusions:

1. In introducing alcohol into the stomach of a living animal we find a part of the alcohol in the course of a certain period of time in the brain, liver and muscles.

2. There is relatively more alcohol in the brain than in the liver and more in the latter than in the muscles.

3. The quantity of alcohol found in the brain, liver and muscles depends upon:

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a) The number of days during which the animal was given alcohol, namely, the longer the animal received alcohol the more do we find it in these organs.

b)The time elapsed between the taking of alcohol and the subsequent death of the animal, namely, the more time passed after the last dose of alcohol the less alcohol do we find, and vice versa, the last time elapsed (not less however than 1 1/2 hours) the more do we find.

P.51 4) Alcohol taken into the stomach gradually spreads about the organism and its maximum is found from 1 1/2 to 2 hours after the dose was taken; then the quantity of alcohol gradually decreases. After 18 hours we hardly find any traces of it?

5) Alcohol when introduced into the vascular system in the absence of the functioning of the organs and coming in contact with the tissues for a more or less long time (in the experiments performed about 2 or 3 hours), is absorbed and fixated by the brain more than by the liver and by the liver more than by the muscles.

6) The strength of the solution of the alcohol is in direct relation to the quantity of alcohol absorbed by the brain, liver and muscles.

7) These strengthened absorption and fixation are more sharply expressed in the brain than in the liver, and more sharply in the liver than in the muscles.

8) The stronger absorption and fixation of alcohol by the brain than by the liver and muscles is explained by the fact that in the brain tissue there predominate, as compared with

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the liver and muscles, which possess a special attraction to alcohol, as their solvent.

This circumstance (conclusion 8) is one of the essential causes of a quicker, deeper, and more harmful action of alcohol on the nerve elements, of the central as well as peripheral nervous system.

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